

Surgical approaches to the mitral valve: A prospective comparative study of the trans-septal approach vs standard left atrial approach

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SUMMARY

Surgical exposure of the mitral valve can be achieved through various approaches depending upon various pathological features of individual case. Each of these approaches has its own merits and demerits. The criteria for selection are not well defined. The left atrial approach is standard and most commonly used approach. The next commonest approach is right atrial trans-septal approach. There is theoretical possibility of rhythm problems following the trans-septal approach as it can damage the atrioventricular conduction system located in the inter-atrial-septum. We did a comparative prospective study to evaluate the safety of trans-septal approach against the gold standard of left atrial approach. All planned mitral valve operations done between January 1991 to May 1993 were included in the study, which included 237 cases operated through left atrial and 25 through trans-septal approach. The patient characteristics and the operative procedures were similar in both groups. All patients in left atrial group were followed for four years and those in trans-septal group could not be followed beyond two years due to various reasons. The results of both groups were compared statistically. We found no statistically significant differences in post-operative characteristics between both groups. There were no conduction block or arrhythmia in trans-septal group and we therefore consider this approach as useful, safe and convenient.

INTRODUCTION

The mitral valve is very frequently operated valve in cardiac surgery. In Pakistan, like other developing countries, a large number of open heart operations are done for the diseases of the mitral valve. The patient profile, timing of operation, nature of pathology and severity of disease varies in different patients. The surgeons are therefore confronted many a times, with a situation where they cannot follow the routine left atrial approach for mitral valve operation. For such circumstances various original as well as modified surgical approaches to mitral valve have been described in the literature.

The main object of this paper is to give a comprehensive review of these approaches and to evaluate the right atrial transseptal approach in greater detail comparing its results with left atrial approach. This study is entirely based on our earlier experience at the Punjab Institute of Cardiology, Lahore. It therefore provides a good reflection of results from a relatively new cardiac centre in a developing country.

PATIENTS AND METHODS

The study consists of the patients who underwent mitral valve surgery at the Punjab Institute of Cardiology,

Lahore, under one surgeon from January 1991 to May 1993. During this period of two and a half years 237 (129 males and 108 females) patients were operated through standard left atrial approach (Group I) and 25 patients (13 males and 12 females) were operated through right atrial transseptal approach (Group II). The average age of patients in Group-I was 29.3 years and in Group-II was 23 years. The (Fig 1) shows histogram of patients distribution according to age.

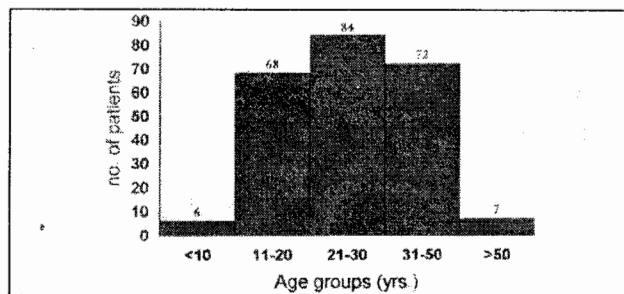


Fig 1. Histogram of age distribution in left atrial group.

The study included only planned operations and excluded all emergency procedures. It was a prospective study and the patients in the Group-I were followed till September 1996 to complete four year follow-up for each patient. However, the follow up of Group-II could not be continued beyond two years due to various reasons.

All patients in both groups had rheumatic heart disease involving essentially the mitral valve and very frequently other valves also. The majority of the patients (i.e. 89/148 in Group I and 19/25 in Group-II) therefore, required additional procedures in combination with mitral valve repair or replacement. Table-1 provides the information regarding the patient characteristics and the operative procedures.

Table 1. Patient characteristics and the operative procedures.

Parameter	Left Atrial Group	Trans-septal Group
Number of patients	237	25
Male	129	13
Female	108	12
Age (Mean±SD) years	29.3±13	23±7
operations		
Isolated mitral valve	148	6
Double valve	72	12
Tripple valve	17	4
Mitral valve+ASD repair	0	3

Clinical Condition and NYHA Class

The main mode of presentation was severe shortness of breath and palpitations. Most of the patients were in NYHA class II and III. Table-2 gives the break-up of NYHA class in Group-II. Group-II patients also had similar inter-class proportions. The preoperative blood counts were within normal range except those patients who had severe tricuspid regurgitation causing enlargement of liver and mild to moderate rise in serum hepatic enzyme levels. All patients had gross cardiomegaly on X-ray chest. The left ventricular dimensions on echocardiogram were much larger than normal. The mean LA size was 57.57 (± 13.56) mm.

Table 2. Pre and post operative NYHA class of trans-septal group.

No. of pts.	Pre-op.	Post-op.		
		6 weeks	12 weeks	24 weeks or >24 weeks
13	II	I	I	I
9	III	I	I	I
1	III	I	I	Died at 3.5 years
1	IV	Died	-	-
1	II	I	Died	I

NHYA= New York Heart Association.

Indications for Transseptal Approach

In the majority of cases (i.e. 17/25) the indication of the transseptal approach was concurrent tricuspid valve disease. Five patient had atrial septal defect in addition to the mitral valve disease and three had very dense

pericardial adhesions. The selection process, however was not randomised.

Operative Technique

In all cases the heart was approached through median sternotomy. After heparinization the cardiopulmonary bypass was established using aortic plus indirect bicaval venous cannulation. However a two stage single venous cannula was used for isolated mitral valve procedures in left atrial group. Anterograde cold St. Thomas' cardioplegia was used for myocardial protection. The systemic temperature was lowered to 28°C and the flow rate was kept at 2.2 litres.min./m². In the trans-septal group the right atriotomy was done anterior to the inter atrial groove. The left atrium was opened through inter atrial septum. The septal incision was made close to the posterior limbus following its normal curvature and was extended very cautiously in superior and inferior direction. We attempted to remain as far away as possible, from the thick anterior limbus and atrioventricular node. Stay sutures were placed on the edge of the fossa ovalis and two small (Ross) retractors were occasional used to retract the edge of the septal incision. After operating upon the mitral valve the septal incision was closed with 2/0 ethibond continuous stitches. The tricuspid valve was then operated. At the end the aortic cross clamp was removed and left ventricular was deaired from right ventricular or pulmonary artery according to the situation. In the left atrial group the left atrium was opened through a vertical incision posterior to the inter atrial groove. For additional procedures on tricuspid valve a right atriotomy was done as described above. The technique for atrial closure was similar in both groups.

The pericardium was left open in all cases and two right ventricular pacing wires were inserted as a routine. We used two pericardial drains and closed the sternum with eight sternal wires. The drain were connected to controlled suction system (Atrium 2002).

Statistical Analysis

Mean and standard deviations were calculated where ever required. Independent sample t-test, Chi-square test and Fisher's Exact test we used wherever appropriate determine the significance of differences between both groups. P-values were calculated on the basis of these tests and difference was considered significant if P-value was <0.05. Kaplan-Meier's method was used to determine survival function over the follow-up period.

RESULTS

Valve Exposure

The exposure of the mitral valve was satisfactory in both groups. It was much superior in the trans-septal

group. In this group lesser retraction was required for better exposure and we found it much easier to put stitches in the anterior part of mitral valve annulus at 12° Clock position which is usually the most difficult part in standard left atrial approach.

Intensive Care Stay and Total Hospital Stay

The average cross clamp time was similar in both groups. The average duration of the stay in the Intensive Care Unit was 26 hours in trans-septal group and 21 hours in the left atrial group. This difference was due to the reason that relatively more patients in left atrial group underwent simple isolated mitral valvotomy. The median hospital stay was six days in both groups.

Postoperative Rhythm, Requirement of Isoprenaline & Inotropic Support:

In trans-septal group, no untoward or unexpected arrhythmia could be encountered in any patients. Thirteen patients maintained their preoperative sinus rhythm. Eight patients who had atrial fibrillations in the preoperative period came off bypass in sinus rhythm, remained in sinus transiently and soon reverted back to their preoperative atrial fibrillations. Four patients who also had atrial fibrillations preoperatively developed various arrhythmias after operation but finally settled to atrial fibrillations within 24 hours. Therefore, all patients preserved their preoperative rhythm. Two patients needed DC cardioversion during rewarming and weaning from bypass. Three patients required isoprenaline for a short period of time for brady-arrhythmias and a similar number of patients needed inotropic support. None of these patients required permanent pacemaker as bradycardia did not persist beyond 24 hours.

In the left atrial group 235 patients maintained their preoperative rhythm and 2 developed new abnormal rhythm. Thirty patients required inotropic support and 27 needed isoprenaline for brady-arrhythmias.

The differences between the groups were not statistically significant.

Postoperative NYHA Class:

All patients showed a marked improvement Post operative NYHA class was definitely better than preoperative and at 24 weeks after operation 92% patients were in class I.

Mortality

In Group-I 18 out of 237 patients died over a period of 24 months. Ten out of 18 patients died within 30 days. Six patients died between 30-90 days after operation two patients died between one and two years after the

operation. The cause of early mortality was low cardiac output and multiple organ failure secondary to septicaemia. The delayed mortality was due to infection and the late deaths were due to coagulation/anticoagulation related disorders.

In the trans-septal group (Group-II) There was no hospital mortality but two patients died in first three months after operation. One of them developed severe endocarditis and the other had a thrombosis of the prosthetic valve (St. Vincents in sortic valve position). Another female patient had sudden death, three and half years after surgery, while she was traveling by train and the cause of death could not be ascertained.

Table 3. Comparison of results.

Parameters	Left atrial group	Trans-septal group	P
Cross clamp time (min.)	81±20.2	83±13.6	>0.67
ICU*stay (median) hours	21	26	NA
Hospital stay (median) days	6	6	NA
Postoperative rhythm change	0	2	0.72
Inotropic requirement	3	30	0.92
Isoprenaline requirement	3	27	0.92

The results are summarised in the Tables 2&3. The survival function is determined and presented in Figure-2 using Kaplan-Meier method.

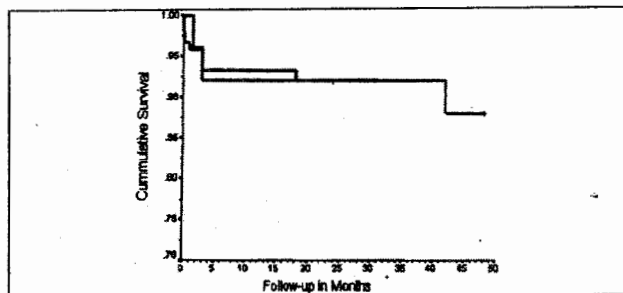


Fig 2. Histogram of age distribution in left atrial group.

DISCUSSION

The mitral valve is perhaps the most commonly operated valve in the third world countries as it is most frequently affected by the rheumatic heart disease. Seven different approaches have been described at different times in literature and all have their own merits and demerits. The evaluation of a particular approach to the mitral valve generally depends on the following important factors:

1. Relative ease of the operation
2. Safety regarding its effect on the atrioventricular conduction pathways.
3. Extent of exposure achieved.
4. Reproducibility of the procedure by surgeons of different levels of skill and experience.

On the basis of these factors we have critically reviewed all reported approaches to the mitral valve in the following paragraphs.

Left Atrial Approach

This is the standard approach for mitral valve operations. The heart is exposed through median sternotomy and heart lung bypass is established. Once the systemic cooling is achieved aorta is clamped and cardioplegia is infused. The left atrium is incised behind the inter atrial groove. The incision is then extended above and below well behind the superior and inferior vena cava to ensure decent exposure. The temptation to make small incision results in tears with nasty bleeding and this temptation should be resisted very strongly.

The left atrial approach has its own limitations in few situations. These include:

- a. In situations where tricuspid valve also require assessment or operation one has to close the left atrial incision after dealing with the mitral valve and then operate upon the tricuspid valve through a separate incision in right atrium. The same applies to a situation when an atrial septal defect is also present concomitantly.
- b. It is extremely difficult to achieve good exposure if the left atrium is too small.
- c. In the presence of a previous rigid prosthesis in mitral or aortic position it makes this approach potentially dangerous as it involves a lot of retraction on the heart.

Septal Superior Approach

This has been described by Craig R. Smith¹. In this approach the incision is made in the mid-lateral wall of the right atrium, extending anteriorly through the mid line of the right atrial appendage, then posteriorly down the back of the appendage to the superior end of the inter atrial septum, leaving 1 to 2 cm of atrial tissue on the ventricular side of the incision to allow closure. Once the septum is visible it is opened beginning at the foramen, extending cephalad with a gentle left curve to join the previous incision at the superior end of the septum. The artery to the sinus node is usually (and unavoidably) divided as the atrial incisions are joined across the top of the septum. The left atrial dome is entered beginning at the junction of the two previous incisions; then the

incision is extended to the base of the left atrial appendage behind the aorta with care. Extension of this portion of the incision into the thin tissues of the appendage is best avoided.

The closure is started at the left end of the left atrial incision at the base of the atrial appendage and is carried as a simple running suture into the septum, where it joins a similar suture started at the inferior end of the septum in the foramen ovale. Right atrial incision can be closed after removing the cross clamp.

This approach is useful mainly in complex reoperations. The effects on atrial conduction and sinus rhythm require further investigation. We recommend caution in choosing this approach especially in patients critically dependent on normal sinus rhythm.

Right Atrial Approach

This has been described by Lynn B. McGrath² for combined mitral and tricuspid procedures. In this technique after standard preliminary steps the right atrium is opened through a usual oblique incision and stay sutures are placed on the right atrial wall for retraction. The septal incision is made in the posterior portion of the fossa ovalis and is extended superiorly and inferiorly. McGrath and his associates have used this approach routinely in combined mitral and tricuspid operations and have recommended for it with full confidence.

Oblique Transseptal Approach

The oblique transseptal left atriotomy described more than 20 years ago by Dobost³ and co-workers, has been referred to as by far the best exposure of the mitral valve. Renee S. Hartz and colleagues⁴ described their experience in 20 patients who underwent mitral valve operations, excision of left atrial myxoma, or endocardial division of left free wall accessory pathway of conduction. Exposure of the mitral annulus was excellent in almost all cases, the incision was easy to close, and the prevalence of postoperative rhythm disturbances was not increased.

In this technique an oblique incision is made in the right atrium between the superior and inferior vena cava and was extended into the right superior pulmonary vein. Although the standard Dubost incision extends anteriorly to the right atrio-ventricular groove, Hartz and his colleagues remained 2.5 cm away from the groove to avoid any conduction problems. The atrial septum is then divided from the junction of pulmonary vein and muscular septum through fossa ovalis. The incision is never made caudal to the limbus of the fossa ovalis, so that injury to the coronary sinus and conduction system could be avoided. A self-retaining retractor is used to lift the septum and this gives very good exposure of mitral valve.

Left Ventricular Approach

This approach can be employed in two situations:

1. During the left ventricular aneurysmectomy when mitral valve needs concomitant replacement. In this situation the ventricle is opened directly through the aneurysm.
2. In congenital mitral stenosis when the subvalvular apparatus needs repair. This can be done either through the left ventricular apex or by a combination of apical as well as left atrial approach. Only a few case reports are found in the literature. The reports of Inaba H et al⁵ and Barbero et al⁶ are worth reading.

Transaortic Approach

This was first video demonstrated by Helseth and associates in 1983 during meeting of Society of Thoracic Surgeons in California. Since then nearly 10 patients have been reported so far. The latest two were reported by Hassan Najafi and James R. Hemp⁷ from Illinois Chicago (1994). This approach like the transventricular is very unconventional and can only be reserved for very rare situation. In the latest report the authors have themselves stated that it was done more out of temptation than for any other particular reason. It can be used in patients with grossly dilated aortic roots due to aneurysms and where the aortic valve is being operated concomitantly.

Transseptal (Fossa ovalis) Approach (Present Study):

In our present study was used standard cannulation techniques and opened the right atrium vertically. The septum was incised in the fossa ovalis along its postero-inferior thin margin did not experience any untoward change in the cardiac rhythm in our 25 patients followed over a period of four years.

The septal incision which we have described in the present study is different from the conventional incision in its position. Although there is concern about increasing the incidence of conduction blocks in the transseptal approaches, we believe that these can be safely avoided by carefully placing the septal incision. We must respect the normal anatomy of the interatrial septum and the modern concepts of the conduction pathways. Contrary to the conventional concepts of discrete conduction bundles, some investigators⁸ believe that there are areas of atrial and septal musculature with better conduction properties. These areas are called preferential pathways of conduction and they anatomically correspond to the previously denoted conduction bundles. Chang and co-workers⁹ have further proved the importance of thick anterior limbus of fossa ovalis in conduction of impulses during normal sinus rhythm.

These findings have changed the understanding of the physiology of atrioventricular conduction. On the basis of these important facts we believe that very safe septal incision can be made by staying away from the anterior limbus. The septal incision we recommend is therefore based on modern knowledge and understanding of conduction pathways.

CONCLUSIONS

The transseptal approach to the mitral valve is a safe and convenient approach if we place the septal incision carefully taking care of conduction pathways. It does not increase the incidence of postoperative atrioventricular block and provides excellent exposure in difficult situations like small left ventricle, dense adhesions, redo-operations, atrial calcification. It is safer in the presence of old rigid prosthesis in aortic and/or mitral positions and it can be used routinely for combined mitral and tricuspid valve surgery.

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